CARLETON UNIVERSITY
Thermodynamics and Heat Transfer
MAAE 2400 Winter 2018

Introduction:

Engineering thermodynamics is the study of energy transformation and utilization and of the various substances used as "working substances" to achieve the transformations desired. Heat transfer is concerned with the "movement" of one form of energy, namely heat, through matter. The development of this science arose from the desire to improve the efficiency of the early steam and gas engines and thus to reduce fuel consumption. This is still a vital task for all engineers. Energy is fundamental to our advanced technological society; it would collapse without abundant supplies of energy. However, energy utilization also involves serious environmental, economic, and social costs. Efficient and intelligent utilization is imperative. It is therefore important that the fundamental principles of thermodynamics and their implications for an energy hungry world be clearly understood by all of us.

This course introduces the First and Second Laws of Thermodynamics which are the foundations of energy conversion processes. The three mechanisms of heat transfer are also introduced. The Laboratory Exercises described in a separate handout are designed to illustrate these principles. Performance tests of energy conversion devices such as engines and refrigeration systems are intended to provide you with experiences in obtaining typical performance data for such machines and in understanding the complexities of experimental work on actual engineering equipment.

To assimilate and understand the course material it is essential to solve problems. The Problem Assignments are provided in a separate handout for this purpose. To obtain any substantial benefit from these, students must work out the solutions themselves. This point cannot be overemphasized.

Course Learning Objectives:

- Obtain a knowledge base of engineering fundamentals in Thermodynamics and Heat Transfer. See detailed topics on the Detailed Course Outline section.
- Gain an ability to use appropriate knowledge and skills to solve engineering problems for thermodynamics and heat transfer related topics.
- Acquire an ability to conduct investigations of thermodynamic problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.

General Information:

SECTION D	
Instructor: Abu Syed Kabir (Office ME3252) E-mail: abu.kabir@carleton.ca	
Lectures: 3 hrs per week in room LA-C164 Tue. and Thu. at 10:05 am - 11:25 am	**Office hours:** After class and/or by appointment

SECTION E	
Instructor: Abu Syed Kabir (Office ME3252) E-mail: abu.kabir@carleton.ca	
Lectures: 3 hrs per week in LA-C164 Tue. Tue. and Thu. at 1:05 am - 2:25 pm	**Office hours:** After class and/or by appointment

Laboratories and Problem Analysis (PA) sessions (depending on the groups):

The labs and Problem Analysis (PA) sessions will be held in alternating weeks. All the lab sessions will be in the Thermodynamics Lab (ME 2230). The PA sessions will be in the designated classrooms and the schedule will be posted later.

Reference Materials:

- Materials Posted on Course Web Page
- Fundamentals of Engineering Thermodynamics, Moran and Shapiro (mandatory)
- License for WileyPLUS electronic resources for Moran & Shapiro (mandatory). This license is bundled with the text when purchased through the CU Bookstore. If you wish to purchase a WileyPLUS license on its own you can do so at http://www.campusebookstore.com/wiley/carleton/
- Heat Transfer, Cengel or Holman (recommended but not required)

Final Examination:

Open book and open notes: One thermodynamics text book (preferably Moran and Shapiro); course handouts; problem set and your own hand written solution/notes. No text book solution manuals are allowed. Standard calculators will be permitted but not laptops, tablets, etc.

According the policy of the Faculty of Engineering and Design, the final examination is for evaluation purposes only and the marked final examination papers are not returned to students.

Laboratories:

To pass the course, in addition to the formal exams, each student must complete successfully all of the four assigned laboratories, submit the required log books, and receive an average grade of at least 50% in the labs. *Incomplete labs or failure to submit log books will lead to a grade of FND in the course.*

If you have previously taken the course, you will need to redo the labs even if you have passed the course or failed but successfully completed the lab portion of the course (According to the policy of the Faculty of Engineering and Design, no exemptions can be granted.)

The laboratory instructions and the laboratory health and safety manual are available on cuLearn. These must be read before attending your first lab. You do not need to return the log books at the end of the term.

Assignments

Problems will be posted on the course webpage on a regular basis to reinforce the lecture material. Students are expected to solve these problems on their own and plagiarism will not be tolerated.

Most of the assignments will be completed and submitted online through WileyPLUS (refer to "reference material" above). *Late assignments will not be accepted.*

Mark Distribution:

Final	65%
Laboratories	15%
Assignments	18%
PA attendance	2%

You need to obtain at least 40 marks out of 100 in the final exam to pass this course. A final mark less than 40 will lead to a grade of F in this course.

Detailed Course Outline:

Week(s)	Topics	Chapter in Class Notes	Corresponding PA Questions
1	Introduction; Concepts and Definitions (Closed System, Open System, Property, State, Process, Steady State, Extensive and Intensive Properties); Units (SI and English Units, Weight-to-Mass Relationship, Density, Specific Gravity, Specific Volume, Pressure, Gauge and Absolute Pressure, Hydrostatic Pressure, Temperature Conversion, Specific Fuel Consumption, Thrust Specific Fuel Consumption)	Chapter 1 Introduction Concepts and Definitions	PA Questions 1
2	Introduction; First Law of Thermodynamics for Closed Systems (Closed System, Statement of First Law for Closed Systems, Convention, Different Formulations); Energy (Kinetic Energy, Potential Energy, Internal Energy); Energy Transfer by Work (Expansion and Compression, Other Examples of Work)	Chapter 2 First Law of Thermo. for Closed Syst.	PA Questions 2
3	Introduction; Continuity Equation (Mass Conservation); First Law of Thermodynamics for Open Systems (General Remarks, Flow Energy, Enthalpy, Statement of First Law for Open Systems)	Chapter 3 First Law of Thermo. Open Syst.	PA Questions 3
4	Introduction; Pure Substance with Phase Change (Diagrams, Phase Change, Pressure-Enthalpy Diagram); Ideal Gases (Ideal and Real Gases, Specific Heats, Internal Energy and Enthalpy, Gas Tables, Polytropic Process of an Ideal Gas)	Chapter 4 Properties of Pure Substances	PA Questions 4 PA Questions 5 PA Questions 6
5	Introduction; Statement for the Second Law of Thermodynamics and Definitions; Thermodynamics Cycles (Power Cycles, Refrigeration and Heat Pump Cycles); The Carnot Cycle	Chapter 5 Second Law of Thermo.	PA Questions 7
6, 7, 8	Introduction; The Definition of Entropy (Clausius Inequality, Definition of Entropy, Tds Relationships, Entropy Change for an Open System, T-s and h-s (Mollier) Diagrams); Entropy Change for Ideal Gases (General Relation, Constant Specific Heats, Isentropic Relations and Polytropic Processes); Ideal Work Relationships for Closed and Open Systems (Polytropic Processes, Adiabatic and Reversible Processes, Incompressible Substances); Entropy Change from Tables; (Ideal Gases, Pure Compressible Substances); Isentropic Efficiencies and Effectiveness	Chapter 6 Entropy	PA Questions 7
9, 10	Introduction; Otto Cycle; Brayton Cycle; Rankine Cycle; Vapour-Compression Refrigeration Cycle	Chapter 7 Ideal Cycles	PA Questions 8 PA Questions 9
11, 12	Introduction; Conduction: Fourier's Law; Convection: Newton's Law of Cooling; Radiation: Stephan-Boltzmann Law; Combined Heat Transfer	Chapter 8 Intr. to Heat Transfer	PA Questions 10

Peer Assisted Study Sessions:
Peer Assisted Study Sessions (PASS) are voluntary weekly study sessions led by peer students who have earned at least an A- in this course. This is a chance for you to get together in a safe, friendly environment with people in your class to compare notes, to discuss important concepts and to develop strategies for studying the subject. Whether your goal is to survive the course or maintain your A average, the PASS facilitator can help you achieve your goal.

The PASS facilitator for this course can be reached by email (pass@carleton.ca). Information on the PASS sessions can be obtained on the PASS website (www.carleton.ca/pass).

Accommodation Statements:
You may need special arrangements to meet your academic obligations during the term. For an

accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: http://www2.carleton.ca/equity/

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: http://www2.carleton.ca/equity/

Academic Accommodations for Students with Disabilities: The **Paul Menton Centre** for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation*** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (*if applicable*) at http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www2.carleton.ca/equity/